The Intercontinental Journal of Emergency Medicine

Original Article

DOI: 10.51271/ICJEM-0026

A comparison of the effects of succinylcholine and rocuronium on recovery time from anesthesia and vital signs in electroconvulsive therapy

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Cite this article: Karaca Bent İ, Köşlük Gürler H, Ekinci O. A comparison of the effects of succinylcholine and rocuronium on recovery time from anesthesia and vital signs in electroconvulsive therapy. *Intercont J Emerg Med*. 2024;2(1):1-5.

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Received: 29/11/2023 ◆ **Accepted**: 27/12/2023 ◆ **Published**: 17/03/2024

ABSTRACT

Aims: Electroconvulsive therapy (ECT) is based on stimulation of brain tissue with an electrical current and the induction of generalized convulsions. The aim of this study was to compare the use of rocuronium as a muscle relaxant and sugammadex as an antidote during ECT with succinylcholine in terms of its effect on adequate anesthesia, hemodynamics, and recovery.

Methods: This study was planned as a single-center prospectively collected and retrospectively analyzed observational cohort study. Patients were divided into two groups as group S (succinylcholine) and group R+S (rocuronium and sugammadex). Patients were premedicated with 0.5 mg of atropine intramuscularly (IM) half an hour before the procedure. Propofol 1mg/kg was administered as an induction agent in both groups, succinylcholine 1 mg/kg in Group S, and rocuronium 0.4 mg/kg in Group R+S. Sugammadex 2 mg/kg was administered as a rocuronium antidote. Vital signs were monitored throughout the procedure with electrocardiography (ECG,) oxygen saturation (SpO_2), and blood pressure monitoring.

Results: There was a statistically significant difference between the two groups (Group S and Group R+S) in the time to return for spontaneous respiration (p=0.002). The mean spontaneous breathing time (SBT) value was 111.78 seconds in Group S and 88.82 seconds in Group R+S. There was a statistically significant difference between the spontaneous eye-opening times between Group S and Group R+S. (p=0.017) The mean spontaneous eye-opening time (SEO) value was 211.42 seconds in Group S and 173.12 seconds in Group R+S. There was a statistically significant difference between Group S and Group R+S in the duration of modified Aldrete score 9 (p=0.000<0.05). The mean duration of modified alderete score (MAS) 9 was 542.60 seconds in Group S and 410.54 seconds in Group R+S.

Conclusion: Although the high cost of rocuronium sugammadex limits its routine use in ECT anesthesia, it can be used as an ideal alternative agent in cases where succinylcholine is contraindicated or anticholinesterases are not suitable because it shortens the recovery time and the time to return of spontaneous respiration compared to succinylcholine.

Keywords: Electroconvulsive therapy, anesthesia recovery period, succinylcholine, rocuronium, vital signs

INTRODUCTION

Electroconvulsive therapy (ECT) is one of the oldest biological treatment methods used in modern psychiatry. ECT is based on the stimulation of brain tissue with electrical current to induce generalized convulsions and is used in the treatment of many psychiatric disorders, especially major depression.

As a result of generalized motor convulsions and cardiovascular adverse cardiovascular responses caused by the electrical current given to patients during ECT, various damages occur in patients. These include severe musculoskeletal system damage, myocardial ischemia caused by a sudden and excessive increase in the oxygen demand of the heart, infarctions, and similar conditions that can lead to severe morbidity and even mortality. Because of this, the need for stabilization and adequate monitoring of patients has come to the fore over the years, and ECT procedures have been performed under general anesthesia since the seventies.[1-4] Many general anesthetic drugs have been used for this purpose over the years.

The duration of general anesthesia to be applied in ECT is very short (1-5 minutes). In order to minimize the traumatic effect of the convulsive seizure during the procedure, it is necessary to administer an anesthetic drug to create short-term amnesia until the effect of the muscle relaxant wears off. For this reason, anesthetics such as thiopental (Thiopental sodium), ketamine, etomidate, and short-acting propofol, which have recently increased in frequency, can be used to provide superficial anesthesia.[5-9] Following superficial anesthesia, succinylcholine (a depolarizing muscle relaxant) or (nondepolarizing) muscle relaxants such as mivacurium, atracurium, and rocuronium can be used to provide muscle paralysis until the end of convulsive activity.[8,9] In ECT

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anesthesia, short-acting muscle relaxants are preferred to avoid long apnea periods. Succinylcholine is a short-acting, depolarizing muscle relaxant that has been used in ECT anesthesia for many years. However, its side effects (myalgia, headache, increase in plasma potassium level, increase in intragastric and intraocular pressure, malignant hyperthermia) and contraindications (musculoskeletal system disease, pseudocholinesterase deficiency, or cardiac disease) have led to the trial of new alternatives.

Currently, rocuronium is increasingly used as an alternative to succinylcholine in ECT. Rocuronium is a steroidal, nondepolarizing neuromuscular blocker with a moderate duration of action. When used at appropriate doses, it is an agent that provides rapid neuromuscular blockade in a manner closest to succinylcholine, making it a good alternative to succinylcholine. The application of rocuronium as a neuromuscular blocker has restricted the use of anticholinesterases as antidotes in patients who are anesthetized outside the operating room and mask ventilation, in whom we want rapid termination of the effect of the muscle relaxant that is not intubated, and has led to the increasing use of sugammadex in anesthesia practice.[10] Gamma-cyclodextrin derivative sugammadex is a new generation reversal agent used to terminate the effects of nondepolarizing neuromuscular blockers (vecuronium and rocuronium). Its mechanism of action is to form a complex with the muscle relaxant in the circulation and at the neuromuscular junction and terminate its effect.[11]

In this study, we aimed to compare whether rocuronium, which is a short-acting muscle relaxant, and sugammadex, which is its antidote, can provide adequate muscle relaxation against succinylcholine and its effect on hemodynamics and recovery during and after the procedure.

METHODS

Study Design and Participants

This study was planned as a single-center prospectively collected and retrospectively analyzed observational cohort study. This study is a specialty thesis in the field of anesthesiology and reanimation. Before 2020, institutional approval was obtained, and ethics committee decisions were not taken for that period. All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki. Our study was conducted in the ECT application room of the psychiatry clinic of the hospital. The necessary equipment for daily anesthesia was available in the room. All patients were informed about anesthesia, and their written and verbal consents were obtained. The study included 100 adult patients aged between 18 and 75 years, in the American Society of Anesthesiologists (ASA) 1-2-3 classification, undergoing elective procedures.

Study Exclusion Criteria

- ASA 4,5
- pregnant patients
- patients allergic to the medicines used

Cases were selected from patients in whom a psychiatric physician gave an indication for ECT, regardless of clinical pathology. Anesthetic consent was routinely obtained from the patients before general anesthesia was started. 50 patients received propofol+succinylcholine, and 50 patients received propofol+rocuronium+sugammadex, totaling 100 patients.

GROUP S (Succinylcholine) (n=50)

GROUP R+S (Rocuronium + sugammadex) (n=50)

Patients were administered routine general anesthetic drugs and premedicated with 0.5 mg atropine IM half an hour before the procedure. Propofol 1mg/kg was administered as an induction agent in both groups, succinylcholine 1mg/kg in Group S, and rocuronium 0.4mg/kg in Group R+S. Sugammadex 2mg/kg was administered as a rocuronium antidote. The vital signs of the patients were monitored throughout the procedure with electrocardiography (ECG), oxygen saturation (SpO_2), and blood pressure monitoring.

Blood pressure, pulse rate, and oxygen saturation (SpO_2) values recorded before and after the procedure, duration of spontaneous respiration, spontaneous eye opening, modified Aldrete score (MAS) of 9, and seizure duration after ECT were analyzed.

Group S (n=50) was premedicated with 0.5 mg of intramuscular atropine approximately 30 minutes before the procedure for each session. ECG, peripheral SpO_2, systolic blood pressure SBP, and diastolic blood pressure (DBP) were recorded noninvasively when the patients were taken to the ECT room. Intravenous infusion of isotonic fluid was started with a 22 G cannula in the dorsal side of the left hand. Electroencephalography (EEG) and electromyography (EMG) electrodes were placed by the psychiatrist, and a blood pressure cuff was tied to the right elbow and inflated to the minimum pressure where the radial artery pulse could not be felt just before induction of anesthesia. After inflating the blood pressure cuff on one arm of the patient, propofol 1 mg/kg IV and succinylcholine 1 mg/kg IV were administered while the patient was preoxygenated. After the patient's fasciculations have passed, the patient's preoxygenation is interrupted by placing a mouth tampon or airway, and the ECT procedure is started; the patient is not ventilated during the procedure. In the follow-up of seizure activities, both EEG recordings, EMG recordings and records of the duration of contraction in the extremity to which the cuff is attached are kept. In our study, we used EEG recordings as the seizure duration. After the procedure is completed, the patient is ventilated again.

In group R+S (n=50), patients were premedicated with 0.5 mg intramuscular atropine approximately 30 minutes before the procedure for each session. ECG, peripheral SpO_2, SBP, DBP was recorded noninvasively when the patients were taken to the ECT room. Intravenous infusion of isotonic fluid was started with a 22 G cannula in the dorsal side of the left hand. Electroencephalography (EEG) and electromyography (EMG) electrodes were placed by the psychiatrist and a blood pressure cuff was placed on the right elbow and inflated to the minimum pressure at which the radial artery pulse could not be felt just before induction of anesthesia. Propofol is administered at a dose of 1 mg/kg intravenous (IV) and rocuronium at a dose of 0.4 mg/kg IV Meanwhile, the patient is preoxygenated. When sufficient muscle relaxation is achieved, preoxygenation is interrupted by placing a tampon or airway in the patient's mouth. The ECT procedure is started, the patient is not mask ventilated during the procedure. After the end of the procedure, the patient is started to be ventilated with a mask again and sugammadex is administered at a dose of 2 mg/kg IV

Blood pressure, pulse rate, and saturation values of the patients before and after the procedure, the duration of spontaneous breathing, spontaneous eye opening, and a

MAS of 9 after the ECT procedure, and seizure durations were recorded in our study.

Statistical Analysis

The Statistical Package for the Social Sciences (SPSS) 23 package program was used for statistical analysis. In quantitative data analysis, variables determined by measurement for descriptive findings were indicated with a mean, median, minimum (min.) value, and maximum (max.) value. The distribution characteristics of the variables specified by measurement were evaluated by the Kolmogorov-Smirnov test. Paired Samples T test was used to compare the differences between the groups (Group S and Group R+S) before and after the procedure, and the Student's T test was used for comparisons between the two groups. P<0.05 was considered statistically significant.

RESULTS

Demographic and Clinical Findings

The study was completed with a total of 100 patients. The mean spontaneous breathing time (SBT) value was 111.78 seconds in Group S and 88.82 seconds in Group R+S. The mean spontaneous eye-opening time (SEO) value was 211.42 seconds in Group S and 173.12 seconds in Group R+S. The mean duration of MAS 9 was found to be 542.60 seconds in Group S and 410.54 seconds in Group R+S. The mean seizure duration was 28.72 seconds in Group S and 31.02 seconds in Group R+S.

There was no statistically significant difference between saturation values and SBP values in Group S before and after the procedure (p=0.346>0.05). There was a statistically significant difference in SBP and DBP, peak heart rate, and heart rate before and after the procedure in Group S (p<0.05) (Table 1).

Table 1. Comparison of pre-procedure and post-procedure vital findings in group S

Groups	Vitals	n (Patient count)	Min	Max	Mean	SD	P
Group S	PrPS	50	95	100	97.94	1.3	0.346
Group S	PoPS	50	96	100	98.22	1.329	
Group S	PrPSBP	50	90	140	111.6	13.265	0,000
Group S	PoPSBP	50	100	170	132.8	15.191	
Group S	PrPDBP	50	60	90	68.9	9.274	0.000
Group S	PoPDBP	50	60	100	78.9	11.486	
Group S	PrPPHR	50	56	119	83.42	14.722	0.000
Group S	PoPPHR	50	63	109	92	11.42	

SD: standart deviation, PrPS: pre-procedure saturation, PoPS: post-procedure saturation, PrPSBP: pre-procedure systolic blood pressure, PoPSBP: post-procedure systolic blood pressure, PrPDBP: pre-procedure diastolic blood pressure, PoPDBP: post-procedure diastolic blood pressure, PrPPHR: pre-procedure peak heart rate, PoPPHR: post-procedure peak heart rate

Group R+S showed a statistically significant difference in systolic blood pressure and peak heart rate before and after the procedure (p<0.05). However, no statistical difference was observed in Group R+S in terms of saturation values and diastolic blood pressure values before and after the procedure (Table 2). The effects of Group S and Group R+S on SBT, SEO, MAS9, and seizure durations were compared in Table 3.

A statistically significant difference was found between the two groups (Group S and Group R+S) in terms of time to return of spontaneous respiration, time to spontaneous eye opening, and time to a MAS of 9 (p<0.05).

Table 2. Comparison of pre-procedure and post-procedure vital findings in group R+S

Groups	Vitals	n (Patient count)	Min	Max	Mean	SD.	P
Group R+S	PrPS	50	96	100	99.1	0.974	0.113
Group R+S	PoPS	50	90	150	99.4	0.969	
Group R+S	PrPSBP	50	90	140	113.5	13.637	0.024
Group R+S	PoPSBP	50	60	90	117.9	14.711	
Group R+S	PrPDBP	50	50	80	67.4	6.869	0.212
Group R+S	PoPDBP	50	59	111	69.1	8.311	
Group R+S	PrPPHR	50	96	100	85.96	12.728	0.001
Group R+S	PoPPHR	50	72	110	91.76	9.224	

SD: standart deviation, PrPS: pre-procedure saturation, PoPS: post-procedure saturation, PrPSBP: pre-procedure systolic blood pressure, PoPSBP: post-procedure systolic blood pressure, PrPDBP: pre-procedure diastolic blood pressure, PoPDBP: post-procedure diastolic blood pressure, PrPPHR: pre-procedure peak heart rate, PoPPHR: post-procedure peak heart rate

Table 3. Comparison of the effects of group S and group R+S on SBT, SET, MAS9, and seizure durations

	Groups	n (Patient count)	Min	Max	Mean	SD	P
SBT	Group S	50	15	223	111.78	45.242	0.002
SBT	Group R+S	50	55	173	88.82	25.541	0.003
SET	Group S	50	75	440	211.42	97.49	0.017
SET	Group R+S	50	91	327	173.12	53.214	0.017
MAS9	Group S	50	310	780	542.6	116.958	0.000
MAS9	Group R+S	50	305	602	410.54	74.741	0.000
SD	Group S	50	12	52	28.72	10.912	0.243
SD	Group R+S	50	19	55	31.02	8.506	0.243

SD: standart deviation, SBT: spontaneous breathing time, SET: spontaneous eye-opening time, MAS9: duration of modified Aldrete score of 9 SD: seizure duration

DISCUSSION

In this study, we compared the effects of succinylcholine and sugammadex rocuronium on vital signs and recovery time in ECT anesthesia. Since seizure duration plays a role in the effectiveness of the procedure, the agents used in anesthesia affect this duration, patient-related factors, and the pharmacological properties of neuromuscular blockers affect the success and safety of ECT, drug selection is important.

Today, ECT is an effective method used in the treatment of many psychiatric disorders. The anesthesia method used during ECT affects both the success of ECT and the oxygenation of the patient during the procedure. Since succinylcholine (SCH), which is frequently used during ECT, causes serious side effects and increases the risk of malignant

hyperthermia, especially in risky patient groups, the need for alternative neuromuscular blockers has increased. Traditionally, cholinesterase inhibitors are used to reverse the nondepolarizing block caused by rocuronium, but these agents have serious side effects, inadequate reversal of deep block, and a risk of recurrence. Sugammadex, on the other hand, is frequently used in anesthesia practice as a new-generation agent that rapidly reverses nondepolarizing block.[12] Its mechanism of action is that it terminates the effect by forming a complex with a muscle relaxant in the circulation and at the neuromuscular junction.[13] For this reason, the use of the new generation reverser sugammadex in ECT anesthesia is increasing.

Turkkal et al.[14] compared rocuronium and succinylcholine for ECT application, as a result of the study, the time to return to spontaneous breathing was found to be longer in patients using rocuronium than succinylcholine; however, no difference was found between both agents in terms of their effects on electroconvulsive therapy. In our study, we found that the time to return to spontaneous respiration was shorter in the group using rocuronium + sugammadex than in the group using succinylcholine. The mean seizure duration was 28.72 seconds in Group S and 31.02 seconds in Group R+S. In our study, no significant difference was found in terms of seizure durations.

In a multicenter study, Lee et al.[15] compared the time to return to spontaneous breathing after administration of succinylcholine at a dose of 1 mg/kg (58 patients) and rocuronium at a dose of 1.2 mg/kg (57 patients) in 115 patients. It was reported that patients who received high-dose sugammadex (16 mg/kg) recovered faster and returned to spontaneous breathing compared to succinylcholine. In our study, succinylcholine 1 mg/kg IV and rocuronium 0.4 mg/kg I.V were used, and sugammadex was administered at a dose of 2 mg/kg. We found that rocuronium and sugammadex were more successful than succinylcholine in restoring spontaneous respiration, even at lower doses.

Sarıçiçek et al.[16] compared the combination of rocuronium +sugammadex with succinylcholine and reported that the patients in the rocuronium + sugammadex group had a shorter time to wake up after anesthesia compared to those in the succinylcholine group, and recovery was faster. In our study, we considered the time to 9 MAS in terms of recovery and concluded that it was significantly shorter in the rocuronium+sugammadex group. There is a study by Batistaki et al.[17] recommending the use of the rocuronium-sugammadex combination in cases where succinylcholine or anticholinesterases as reversal agents are contraindicated. In our study, we showed that the use of rocuronium+sugammadex is a suitable alternative in cases where succinylcholine or anticholinesterases are contraindicated or cannot be used. Trzepacz et al.[18], Mitchell et al.[19] and Avramov et al.[20], showed that propofol anesthesia shortens the seizure duration without affecting the efficacy of ECT when compared with methohexital, etomidate, and thiopental anesthesia. In our study, we preferred propofol, which has a short duration of action and has little effect on seizure efficacy, as the induction agent. This agent has side effects such as nausea and vomiting, but we did not encounter such side effects in our study.

Şanlı et al.[21] used 1 mg/kg rocuronium and 16 mg/kg sugammadex as antidotes during ECT sessions in a patient who developed neuroleptic malignant syndrome after antipsychotic drug use. The patient underwent 11 sessions of ECT, and the duration of spontaneous eye opening was 7 minutes. They observed that there was no significant change in the vital signs of the patient before and after the procedure. Both studies show the safety of rocuronium as an alternative muscle relaxant and sugammadex as an antidote, which can be used without increasing the risk of malignant hyperthermia during ECT in patients with neuroleptic malignant syndrome.

CONCLUSION

Although the high cost of sugammadex limits its routine use in ECT anesthesia, it can be used as an ideal alternative agent in cases where succinylcholine is contraindicated or anticholinesterases are not suitable because it shortens the recovery time and the return of spontaneous respiration compared to succinylcholine.

ETHICAL DECLARATIONS

Ethics Committee Approval

This study is a specialty thesis in the field of emergency medicine. Before 2020, institutional approval was obtained, and ethics committee decisions were not taken for that period.

Informed Consent

Written informed consent was obtained from the patients participating in this study.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

Author Contributions

All of the authors declared that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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